

Atlantic Puffin *Fratercula arctica* fishing in a freshwater lake to feed its chick

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Abstract

We present details for the observation of an adult Atlantic Puffin *Fratercula arctica* collecting food in Lake Linnévatnet (78°02'N 13°48'E), the second largest freshwater lake in the Svalbard archipelago, on 11 August 2020. The bird was seen frequently diving and accumulating fish in its bill. All circumstances considered, we think the bird intended to feed a chick in the nearby Vardeborg colony. This is the first published record of a breeding Atlantic Puffin searching for food in freshwater. We discuss this finding in the light of the scarce information available on the species' feeding ecology in high-arctic breeding areas.

Introduction

Well-known to most readers of *Seabird*, the Atlantic Puffin *Fratercula arctica* (hereafter 'Puffin') is one of the most typical and abundant pelagic seabirds, with a total population of about 6–7 million breeding pairs spread across the North Atlantic (Harris & Wanless 2011). This charismatic auk breeds in colonies ranging from a few tens to hundreds of thousands of breeding pairs spread across the northern North Atlantic from Maine to Greenland in the west and from France to Svalbard and Franz Josef Land in the east (Harris & Wanless 2011). The species' stronghold is the southern and eastern parts of the Norwegian Sea, where the



Figure 1. Lake Linnévatnet seen from the north, approximately from where the foraging Atlantic Puffin *Fratercula arctica* was observed. The southernmost part of the Vardeborg mountain ridge rises up at the right side. © Martin-A. Svenning.

largest colonies are found on islands in southwest Iceland, the Faroes, Scotland and along the northwestern coast of Norway.

In the chick period, breeding Puffins usually forage within 50 km of their colony, with trip length being negatively correlated to food conditions (Fayet *et al.* 2021). They typically raise their single chick on small (usually 5–15 cm long) schooling fish such as sandeels (Ammodytidae), Herring *Clupea harengus*, Sprat *Sprattus sprattus* and Capelin *Mallotus villosus*, carried crosswise in the bill in loads of around 10 (normal range 1–20) fish at a time (Harris & Wanless 2011). These forage fish are often abundant and high in lipid content in summer, but Puffins also feed on a wide variety of other prey including leaner young gadids (Gadidae) and transparent larvae of Herring as well as small crustaceans, especially when food availability is poor (e.g. Barrett *et al.* 1987; Anker-Nilssen *et al.* 2000; Fayet *et al.* 2021).

There are many more colonies in the Svalbard archipelago than e.g. along the Norwegian mainland (Anker-Nilssen *et al.* 2000) but they are small. Except for the colony on Gåsøyane (78°27'N 16°13'E), which holds about 1,000 pairs (S. Descamps, unpubl. data), all probably have less than 500 pairs (Norwegian Polar Institute (NPI) Colony Registry; SEAPOPOP database www.seapop.no). Although summers are milder in western Svalbard than farther east in the Barents Sea, Puffins breeding this far north are near their limits in terms of climate conditions, lack of soil suitable for nest burrows and low availability of small schooling fish, the Puffin's preferred prey in more boreal

waters. These factors help explain why the total breeding population in Svalbard is only estimated at about 10,000 pairs, spread over approximately 60 different colonies (Anker-Nilssen *et al.* 2000; Strøm 2006a). Most colonies are situated on the west coast of Spitsbergen, the largest island in Svalbard, where they usually breed in crevices high up in the least accessible (for Arctic Foxes *Vulpes lagopus*) parts of the highly eroded hillsides typical of the Svalbard landscape, but Puffins also breed in boulder scree on some of the few small islands spread along that coast (Strøm 2006a).

The observation

Between 20:20 and 21:05 local time (GMT + 2 hrs) in the evening of 11 August 2020, Georg Bangjord (hereafter GB) visited the north shore of Lake Linnévatnet (78°02'N 13°48'E; Figure 1) to look for waterbirds. With an area of 4.6 km² and a max depth of 37 m, this lake is the second largest body of freshwater in Svalbard (Bøyum & Kjensmo 1978). It is situated at the neck of land protruding north into the outlet of Isfjorden on the west coast of Spitsbergen, about 10 km west of the Russian settlement Barentsburg (Figure 2). The upper part of the Vardeborg mountain ridge, which is located immediately northeast of Linnévatnet and rises up to 589 m above sea level, is home for a small Puffin colony facing west towards the lake (Figure 3). Its exact population size is unknown, but at least 50 adults were seen on the colony surface when the observation was made (GB pers. obs.), suggesting it may have around 100 breeding pairs. The colony lies within 1.5 km from the lake and only about 3 km from the nearest sea areas in the mouth of the



Figure 2. The position of Lake Linnévatnet at the mouth of Isfjorden at Spitsbergen, Svalbard. The polygons show the approximate locations of the foraging Atlantic Puffin *Fratercula arctica* and of the Vardeborg Puffin colony (red). The observation was made from the site marked by a green circle. Map images: © Google Earth, IBCAO.

fjord to the northwest. Most birds breed at an elevation of around 350 m in the central part of the colony area indicated in Figure 3, which also holds many pairs of Northern Fulmars *Fulmarus glacialis*, a few pairs of Black Guillemots *Cephus grylle* and 1–2 pairs of Glaucous Gulls *Larus hyperboreus*, possibly also some pairs of Little Auks *Alle alle* (GB pers. obs.).

When scanning Linnévatnet with a high-quality telescope (Swarovski ATX 30–70x95) from a slight elevation about 1 km away, GB spotted an adult Puffin on the water surface. The bird was located over the deepest part of the lake (Figure 1), and was seen actively diving for prey and clearly accumulating fish in its bill. During the c. 20 minutes GB and two other observers focussed on this Puffin before they had to leave, it dived at least 4–5

times and spent more time under water than on the surface. Observations were conducted during a period of calm weather, with light cloudiness and good visibility. At this latitude and time of year there is continuous daylight, and GB is also well acquainted with observing the foraging behaviour of Puffins at many other colonies.

Discussion

As Puffins are not known to carry fish in the bill for other purposes than chick-feeding, we are confident that the food load collected by the Puffin in Linnévatnet was intended for, and eventually delivered to, its nestling. As it was not seen leaving the lake, we cannot prove it was breeding in the nearby Vardeborg colony. Still, this stands out as the most likely explanation, given that the second-nearest Puffin colony is located 16 km

away at Alkhornet (78°13'N 13°49'E) on the opposite side of the fjord (NPI Seabird Colony Register; SEAPOP database www.seapop.no). When the observation was made, at least 50 adult Puffins were seen sitting on the colony surface, indicating many more breeders were still active.

The time of year also fits well with the phenology of Puffins in western Spitsbergen. Observations posted at Artsobservasjoner (www.artsobservasjoner.no), the Norwegian Biodiversity Information Centre online database, suggest that the first birds usually arrive in the Isfjorden area in mid-May (the earliest seen by GB was on 22 May 2018). This is about a month later than at Bjørnøya (74°30'N 19°00'E; V. Ivarrud pers. comm.), the southernmost island in Svalbard, and almost two months later than on the

coast of northern Norway (Burr *et al.* 2016). At Gåsøyane, which is situated 70 km northeast of Linnévatnet in the inner part of the fjord, median hatching date of Puffins in 2015–19 was 21 July (S. Descamps unpubl. data), indicating that mid-August is well within the normal chick period for Puffins in western Spitsbergen. This is further corroborated by numerous observations of chick-feeding Puffins in the Isfjorden area over many years, where Puffins are often seen feeding chicks into early September (GB pers. obs.). The latest time of year GB has seen a Puffin bringing a food load to a colony was at Gåsøyane on 28 September 1996, and on 7 October 1997 he observed an adult bird actively diving near Kullkaia (72°14'N 15°33'E), 12 km northwest of Longyearbyen harbour. The latter is still the latest observation of the species ever



Figure 3. The Vardeborg mountain ridge seen from the north side of Lake Linnévatnet. Within the main colony area (approximately delimited by green lines), most Atlantic Puffin *Fratercula arctica* breed in the steepest parts in the centre of the ridge (orange rectangle). These areas are easily recognised by the green-coloured slopes immediately underneath, a typical result of the fertilising effect of cliff-breeding seabirds on the scanty vegetation in Spitsbergen. © Martin-A. Svenning.

registered in nearshore waters at Spitsbergen (detailed search made on www.artsobservasjon.no).

Due to the logistic difficulties associated with observing birds at their colonies and accessing nests and adults for more detailed studies, very little is known about the demography and ecology of Puffins breeding in the High Arctic, including the composition of their main food base. Compared to the highly piscivorous diet Puffins bring their chicks in most colonies, analyses of stable isotope levels in feathers grown at other times of year indicate they may often feed on a lower trophic level outside the breeding season (Hedd *et al.* 2010; St. John Glew *et al.* 2019). The lack of large forage fish stocks in High Arctic waters therefore makes it reasonable to expect invertebrate prey is more common there than in temperate breeding areas. There is relatively little information on what Puffins feed their chicks in Spitsbergen but a recent study at Gåsøyane (Underwood 2019) suggests that Arctic Cod *Boreogadus saida* is an important prey and the diet there also included Herring, Capelin, pricklebacks (Stichaeidae) and sandeels, but no invertebrates. The latter contrasts the findings of Hartley & Fisher (1936) who found that small crustaceans (genera *Thysanoessa*, *Parathemisto* and *Mysis*) dominated in stomachs of 10 adults collected at Spitsbergen late in one breeding season, yet the adults themselves may of course feed on different (and smaller) prey than that they provide for their chicks and seven of the birds' stomachs also contained fish (gadids and pricklebacks). Uspenski (1956) reported that similar sampling of 20 Puffin stomachs at Novaya Zemlya, northwest Russia, in August 1948–50

suggested *Nereid* worms were a main food item there, and only five of those birds contained fish (three with Fourhorn Sculpin *Myoxocephalus quadricornis*, and two with sandeel). All these prey are marine species, as is also the case in all other studies of Puffin diet that we are aware of (see Harris & Wanless 2011 for the most recent summary). The Puffins breeding on Bjørnøya in 2015–16 fed their chicks exclusively fish, mostly Daubed Shanny *Leptoclinus maculatus*, but also considerable amounts of Capelin, sandeels and gadoids (Hornset 2017).

Even if invertebrates are a more important prey for auks this far north than elsewhere, it is not surprising that local sources of small fish attract Puffins, especially when found close to the colony. Although the observation distance made it impossible to see what species of fish the Puffin in Linnévatnet was feeding on, the answer is fortunately simple given that there is only one species of freshwater fish in Svalbard, the Arctic Charr *Salvelinus alpinus* (disregarding one record of a Three-spined Stickleback *Gasterosteus aculeatus*; Svenning *et al.* 2015). Linnévatnet has a viable population of Arctic Charrs, the major part of which is anadromous (Svenning *et al.* 2007; Bergane 2018). The median length of 273 Charrs captured during test fishing with 5–8 mm mesh bottom nets set at 0–18 m depth in the lake on 19–20 September 2017 was 12 cm (range 6–50 cm) with 72% being 10–14 cm long (Svenning *et al.* 2020). Thus, most fish available for the Puffin in Linnévatnet were probably well within the normal size range of fish prey taken by Puffins (cf. Harris & Wanless 2011), which now counts one more species.

We are not aware of any studies of energy content of freshwater fish in Spitsbergen, but the average calorific value for approximately 11 cm long immature Arctic Charrs sampled in an oligotrophic mountain lake in Central Norway on five occasions in August and September of years 1998–2000 ranged between 5.3–6.2 kJ per g wet weight (Finstad *et al.* 2003). This is pretty similar to the quality of lipid-rich prey of Puffins elsewhere (Anker-Nilssen & Øyan 1995; Barrett *et al.* 2002) and presumably not very different from that of marine fish or suitably-sized crustaceans in the Isfjorden area in early autumn.

Beside Arctic Terns *Sterna paradisaea*, Common Eiders *Somateria mollissima* and Long-tailed Ducks *Clangula hyemalis*, which all breed on a small island in the southern part of Linnévatnet, GB has seen several other bird species feeding in the lake. The list includes Red-throated Diver *Gavia stellata* and King Eider *Somateria spectabilis*, both well known to breed near freshwater lakes in Spitsbergen, as well as up to eight Black Guillemots at a time. At the time that the Puffin was spotted, about 20 Arctic Terns were present at the lake, and this species is also seen fishing in many other lakes on Spitsbergen (GB pers. obs.; M.-A. Svenning pers. comm.). Black Guillemots are known to feed in near-coast freshwater lakes elsewhere (e.g. Audubon Society 2021) and have been found breeding up to 2–3 km inland in Spitsbergen (Birulya 1910; Strøm 2006b). In connection with fish surveys in the River Linné (Linnéelva), which joins Linnévatnet with the sea, Kjell Joar Nilssen (pers. comm.) noted that the river outlet occasionally

attracts Black Guillemots, whereas Glaucous Gulls visit this area on a daily basis in late summer (GB pers. obs.). Both species are likely to feed on young Arctic Charr, but as the outermost part of the river, Russekeila, is a brackish-water pool that is regularly flooded at high tide (average tidal difference 105 cm; Kartverket 2021), we cannot exclude there are also other prey of interest there for these birds. There are also some rare observations of Little Auks there, but it is difficult to exclude the possibility these were newly fledged young (which may be difficult to distinguish from adults) failing to reach the sea on their first flight from the nest.

We are not aware of any other reports documenting that Puffins, or other highly pelagic oriented seabirds for that matter, visit freshwater lakes in search of food for their young. On the Isle of May, southeast Scotland, small groups of Puffins are regularly seen rafting on an artificial freshwater loch located immediately downside of a slope inhabited by Puffins, but none of them has ever been seen carrying food and the lake contains no fish (M. P. Harris and M. A. Newell *et al.*, pers. comm.). There are a few records of Puffins found inland (e.g. Vickery 1979; Underwood & Stowe 1984 and undocumented observations posted at Artsobservasjoner), but such observations seem to stem exclusively from the non-breeding period and are likely of birds blown inland by extreme weather events. This phenomenon is also more often reported for other auk species, including Common Guillemot *Uria aalge*, Razorbill *Alca torda* and Little Auk (e.g. Underwood & Stowe 1984; Isaksen & Bredesen 2007;

Heubeck *et al.* 2011), perhaps because they are more numerous than Puffins in coastal waters at that time of year.

As Linnévatnet is not often visited by ornithologists within the chick period of the local Puffins, it is difficult for us to assess whether the Puffin seen foraging there was only a rare one-off event or if Arctic Charr from the lake sometimes may constitute a significant part of the chick diet in the nearby colony, for instance in periods of poor availability of local marine prey. We have no clear indications of poor conditions for breeding in Isfjorden in 2020, but a much lower density of apparently occupied Puffin nests at Gåsøyane compared to that in the previous five years (S. Descamps pers. comm.) could well be a result of low food availability.

For obvious reasons, freshwater prey is highly unlikely to be an important component of the diet of Puffins, but our brief review shows that little is known about the feeding ecology of this species in high-arctic areas. More detailed studies are warranted to shed light on how these populations will respond to possible changes in their prey base induced by climate change.

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